Using Radiant Glass for Melting Snow & Ice on Solar PV & Solar Thermal Panels

State-of-the-Art Low-E radiant glass technology uses minimal electricity to melt snow and ice when temperature drops below 32°F.

Energized Radiant Glass - Snow Melt Test

Test conditions for November 04, 2013: 3 inches of snow

Glass used for test:	PPG Sungate 500 Low-E radiant glass
Dimension:	22.625 inches x 67 inches = 10.5 ft.^{2}
Buss bar dimension:	on 22.625 inch legs
Measured sheet ohms:	67.7 = 24.3 ohms/ft.^{2}
Cur. flow when on:	1.773 amps
Lead to Buss bar:	None
Bus Bar type:	0.005 x 0.25 inches (½ hard copper style)
Transfer agent:	3M 9707 XYZ tape
Bus Bar to glass:	22.6” x .25” = 5.7 sq.in. = 0.313 amps/sq.in.
Maximum watts:	212.8 = 20.3 watts/ft.^{2}

Energized Glass: 2013 Snow Melt Test

Snowmelt test set up:
Outside Air Temperature of
6°F, test began at 7:20 am. Colorado snow accumulation of
2-3 inches on lower half of the solar photovoltaic (PV) panel.

At 100% of power supply capacity, the system will draw ~10.7 watts/ft^2/hr. at 80% cycling. That is equivalent to 160.5 watts for a 15 ft^2 250 watt solar panel, or 642 watts per kW of power generated for melting 2-3 inches of snow.

Energized Glass: 2013 Snow Melt Test cont.

At 7:40 am, 20 minutes after the radiant glass had been activated, 30% of the snow has melted.

Energized Glass: 2013 Snow Melt Test cont.

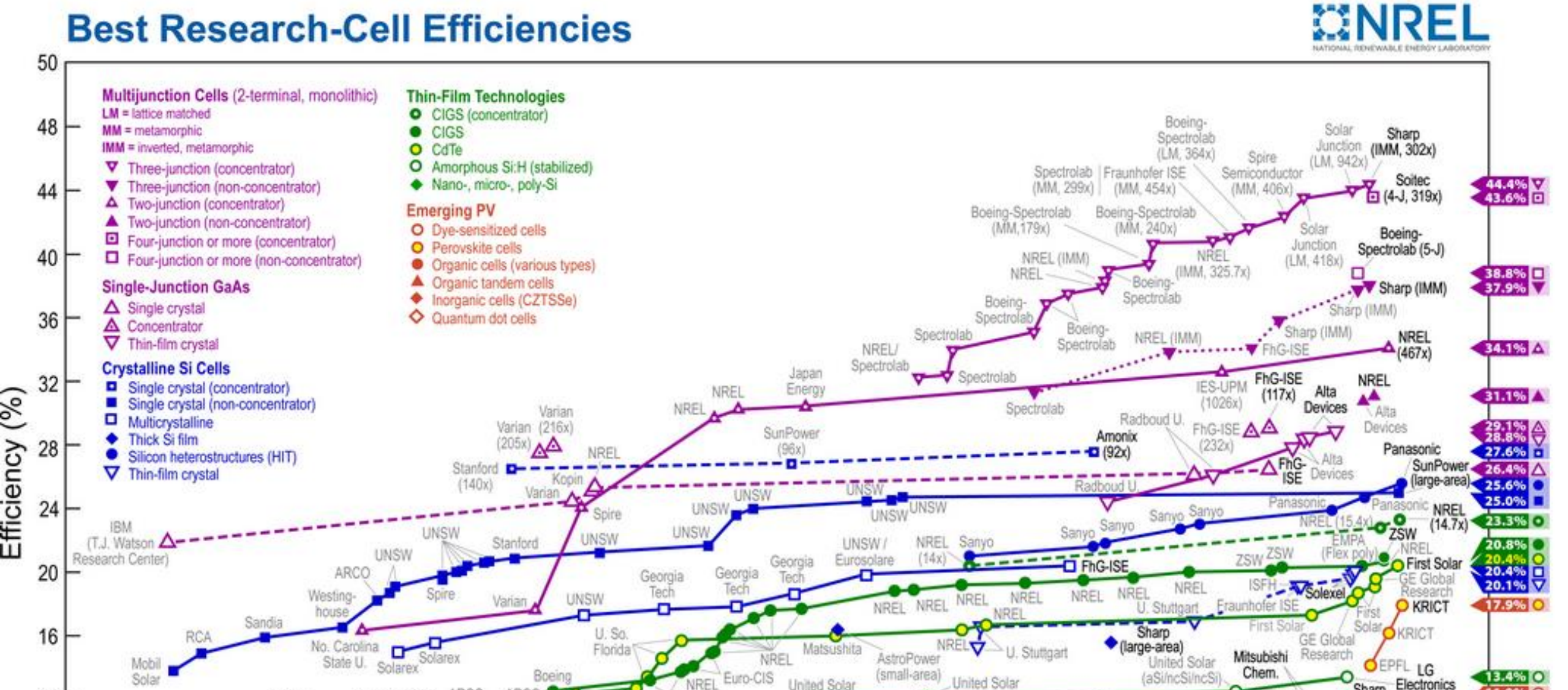
At 8:00 am all of the snow on the glass cover of the solar PV panel has melted. Total elapsed time was 40 minutes.

By 9:15 am all of the moisture has evaporated from the glass cover of the solar PV panel. Total elapsed time was ~2 hr.

Solar Cell/Panel Efficiencies

- Though conventional solar panels are currently achieving only ~15-20% electric efficiency, progressive solar panel technology manufacturers such as Sun Power are currently achieving 24% electric efficiency through innovative design.
- Solar concentrator technologies are increasing electric efficiencies by two fold with objectives of eventually reaching 70%.
- In addition, solar tracker technologies can increase productivity by up to 45%.
- Obviously, provided the initial cost of purchase can provide a 3-5 year ROI, solar concentrator and tracker technologies offer the most appealing opportunities for enhancing productivity using radiant glass technology.

44.4% Solar Cell Efficiencies



Selection of Low-E Glass for Solar Panels

- A strong exterior glass that can withstand hail and heavy snow loads is necessary to insure performance of solar panels in temperate environments.
- High solar transmittance and low exterior emittance in conjunction with a Low-E coating allows for integration of radiant glass technology.

LBNL Glass Data Base (IGDB) version 38

Glass Library (C:\Users\Public\LBNL\WINDOW7\w7.mdb)

ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	emis1	emis2	Cond
							mm										W/m-K
2008	x89-5.CIG	x89 on 5mm Clear	Cardinal Glass Industries	IGDB v29.0	#		4.700	0.727	0.090	0.094	0.879	0.070	0.070	0.000	0.192	0.840	1.000
5240	S500CL_2.PPG	Sungate® 500 on Clear	PPG Industries	IGDB v11.4	#		2.261	0.727	0.127	0.112	0.838	0.113	0.109	0.000	0.215	0.840	1.000
1843	030CL2_7.SOI	Saflex® Clear	Solutia	IGDB v11.4	#		6.160	0.727	0.069	0.068	0.885	0.079	0.079	0.000	0.840	0.840	0.638
701	Comfort E-PS_2.AFG	Comfort E-PS Low E	AGC Glass Co. N.A.	IGDB v17.3	#		2.210	0.727	0.110	0.103	0.845	0.106	0.100	0.000	0.148	0.840	1.000
5229	SG400 Starphire_5.PPG	Sungate® 400 Starphire®	PPG Industries	IGDB v17.4	#		4.674	0.728	0.177	0.158	0.879	0.064	0.072	0.000	0.115	0.840	1.000
3073	C_Lam33.2.grd	Clear laminate (3mm+.060"PVE	Guardian	IGDB v15.4	#		7.468	0.728	0.070	0.069	0.881	0.082	0.081	0.000	0.840	0.840	0.568
4330	stratobel 44.2.gvb	Stratobel 44.2	AGC Glass Europe	IGDB v18.1	#		8.460	0.729	0.067	0.067	0.878	0.079	0.079	0.000	0.840	0.840	0.754
4441	stratophone 44.2.gvb	Stratophone 44.2	AGC Glass Europe	IGDB v18.1	#		8.460	0.729	0.067	0.067	0.878	0.079	0.079	0.000	0.840	0.840	0.754
1861	045CL2_3.SOI	Saflex® Clear	Solutia	IGDB v11.4	#		5.740	0.729	0.069	0.068	0.887	0.079	0.079	0.000	0.840	0.840	0.542
13008	NsolarC4.arc	arcon N solar on clear4	arcon	IGDB v16.3	#		3.900	0.729	0.177	0.155	0.890	0.066	0.073	0.000	0.092	0.840	1.000
8240	YBD0178_6.syp	Solar Reflective on Clear	SHANGHAI YAOHUA PILKING	IGDB v15.4			6.000	0.730	0.137	0.152	0.783	0.184	0.193	0.000	0.840	0.820	1.000
3300	CGIS-20_2L15.grd	ClimaGuard IS-20 exposed clr l	Guardian	IGDB v18.1	#		4.089	0.730	0.088	0.093	0.871	0.092	0.092	0.000	0.836	0.198	0.743
5228	SG400 Starphire_4.PPG	Sungate® 400 Starphire®	PPG Industries	IGDB v17.4	#		3.912	0.730	0.177	0.160	0.880	0.064	0.072	0.000	0.115	0.840	1.000
9922	EnAdvLE4.LOF	Energy Advantage‖ Low-E	Pilkington North America	IGDB v17.4	#		3.900	0.731	0.119	0.111	0.840	0.111	0.106	0.000	0.164	0.840	1.000
9037	Hygard-CG_500 Clear_1	Hygard CG 500	Bayer MaterialScience	IGDB v30.0			13.027	0.732	0.060	0.060	0.792	0.061	0.061	0.000	0.900	0.900	0.200
2088	Clear-L68.CIG	Clear-2.7 / .060 PVB / Clear-2.	Cardinal Glass Industries	IGDB v20.0	#		6.930	0.732	0.078	0.077	0.884	0.091	0.091	0.000	0.840	0.840	0.549
5227	SG400 Starphire_3.PPG	Sungate® 400 Starphire®	PPG Industries	IGDB v17.4	#		3.277	0.733	0.177	0.161	0.880	0.065	0.072	0.000	0.115	0.840	1.000
892	CLR_10.AFG	Float Glass	AGC Glass Co. N.A.	IGDB v11.4	#		9.500	0.733	0.065	0.065	0.859	0.075	0.075	0.000	0.840	0.840	1.000
5305	SN-5.ppg	SunClean® on Clear	PPG Industries	IGDB v14.1	#		4.674	0.734	0.147	0.134	0.787	0.191	0.185	0.000	0.837	0.842	1.000
2806	AM5CL_ESP	Armour Glass Clear	Energy Saving Products of El	IGDB v17.2			5.000	0.734	0.095	0.102	0.855	0.112	0.113	0.000	0.840	0.936	0.791

High Solar Transmittance (Tsol) & Low Emissivity (emis1) Glass Options

- According to version 38 of the LBNL glass library, Low-E coating, exterior glass cover for a solar panel could be comprised of the following options [0.125 (1/8) inch = 3.175 mm]:
  - PPG Sungate 500 clear 2.261 mm, Tsol-0.727, emiss1-0.215
  - Comfort E-PS Low-E, 2.21 mm, Tsol-0.727, emiss1-0.115
  - PPG Sungate 400 Starphire, 4.674 mm, Tsol-0.728, emiss1-0.115
  - PPG Sungate 400 Starphire, 3.912 mm, Tsol-0.730, emiss1-0.115
  - PPG Sungate 400 Starphire, 3.227 mm, Tsol-0.733, emiss1-0.115
  - Cardinal x89 clear, 3.90 mm, Tsol-0.738, emiss1-0.192

Increasing Sun Hour Days

- For solar passive applications, rule of thumb is to estimate solar PV production based on average sun days of 4 hr. during the summer in Boise, ID. If radiant glass technology could extend that to 6-7 sun hr. days in the summer, perhaps 4-5 hr. sun hr. days during the fall, winter, and spring seasons by maintaining an outside temp. of 35°F via an automatic temp. sensor, this would allow for melting snow as well as frost and ice, etc.
- Active applications, e.g., solar trackers (GPS or photo-sensors), could achieve a 30-45% increase in productivity and could be even more appealing for tracker technology applications.

kW Bundling for Radiant Glass Packages

- If initial costs of the radiant/energized glass could be reduced by packaging the radiant glass technology in one kW bundles, then a single power supply and radiant controller could be sufficient for 60 sqft (four 250 watt panels) of low-E coated glass.
- Solar thermal collectors are substantially larger, e.g., 4'x10' and should similarly benefit from snow melting via radiant glass. This would be ideal for integration of solar thermal with radiant floor heating systems that leverage the thermal masses of concrete and water, particularly in conjunction with thermal battery systems.

Potential ROI

- With costs of solar PV predicted to drop to $0.35/watt by 2017 due to increasing demand, there is an opportunity for the average homeowner to invest in solar PV technology, particularly if productivity can be enhanced through economic radiant glass technology.
- For example, a 25% increase in productivity for a 1 kW system, say from 4 hr. sun days to 5 hr. sun days via year round radiant snow and ice melting, would annually boost kWh by 365. At a retail rate of $0.10/kWh, that would amount to $36.50 in additional electricity production minus electricity required for radiant glass application.
- Subject to actual validation for a controlled study, provided this estimated projection is accurate and costs could be contained for bundling 1 kW radiant glass modules (four 250 watt panels) using the same radiant controller and power supply, that would provide a ROI of less than a year.

1 kW Modular Kits for Radiant Glass Technology

- Most solar PV systems are at least 1-3 kW systems even for passive house applications. Hence, bundling the radiant technology with 1 kW systems/modular kits would probably be most appealing for the consumer as well as the solar panel manufacturer.
- It would certainly appear to add the most value vs. attempting to provide the radiant technology with separate controller and power supplies for each 250 watt panel.